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Psychological and Physiological Correlates  
of Stress: Performance on a Cooperative Task

(NAS 9-13452)

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## Final Report

Contract No. NAS 9-13452: "Psychological and Physiological  
Correlates of Stress: Performance on a Cooperative Task"

### Introduction

Recently this laboratory has been concerned with the relationship of personality dimensions to performance with particular emphasis on the possible physiological response components which would predict performance decrement in the various personality "types." (Roessler, Final Report NASA NGR 44-003-031; Roessler and Lester, Final Report NAS 9-11753; Lester et al, 1975; Lester et al, 1975a) The sleep deprivation stressor situation brought together subjects who had a variety of personality characteristics. Observation of subjects under these experimental conditions suggested that certain combinations of persons with various personality characteristics were likely to cause additional deterioration of performance, beyond that expected from the planned stress. The earlier studies however failed to systematically vary these personality type combinations and therefore prevented any meaningful comparison of the effects. The current research project attempted to systematically manipulate the effects of personality type combinations on performance--specifically on a cooperative task, the Prisoner's Dilemma (Lindsey and Aronson, 1969).

Research on the cooperative task called the Prisoner's Dilemma (PD) has often been difficult to interpret due to conflicting and/or mixed results. For example, subjects who choose a competitive strategy in one PD task may cooperate in another situation which apparently is influenced by the same variables (Sermat, 1970). This is likely to be due to variables other than those in the payoff matrix (Steiner, 1972). Some investigators attribute much of the variance in PD to personality characteristics (Terhune, 1968, 1970; Wrightsman, 1966). The personality characteristics which were measured in the current study were the Barratt Impulsiveness Scale (Barratt and White, 1969), the Eysenck Personality Inventory Scales (Kaplan et al, 1965) and the nurturance and succorance sub-scales of the Edwards Personal Preference Inventory (Edwards, 1959) and a mood scale or adjective checklist (Taub and Berger, 1974). In addition to the personality characteristics of the individual participants some consideration must be given to the interaction between these two individuals (Rapoport and Chammah, 1965).

In addition, the perceived characteristics of the other person affects the amount of cooperation displayed (Lave, 1965). Past research has shown the high authoritarianism subjects were both less trusting and less trustworthy during the PD test than subjects low on authoritarianism (Deutsch, 1960). A comparison of cooperative and competitive persons as defined by their PD behavior revealed a basic difference in the way in which they viewed human nature (Kelly and Stahelski, 1970); cooperators tend to believe others are heterogeneous as to their cooperativeness/competitiveness, whereas competitors tend to believe other persons are uniformly competitive.

The present study was designed to investigate the relationship of personality dimensions to performance. The personality measure used to select subjects, the Barratt Impulsiveness Scale, is hypothesized to be related to a style of behavior which should affect the trend of choices which various subjects will make. Additionally, it is hypothesized that the physiological status of each subject prior to registering his choice should contribute to prediction of his cooperation or noncooperation on a given response. Thus those persons who view the situation as competitive should show higher physiological responsivity than those who are cooperative. The mood scale scores were expected to be related to the style of response adopted--i.e., those subjects reporting more negative mood states prior to the beginning of the experiment would be expected to cooperate less than those reporting positive mood states. It was also expected that the opportunity to communicate between the two sets of trials would increase the cooperativeness evidenced by all participants.

### Method

Subjects: The Barratt Impulsiveness Scale (BIS) was used to select 41 male and 41 female college age subjects such that their BIS scores were  $\pm 1.75$  standard deviation from the mean. Subjects were assigned to pairs of like gender or unlike gender and to similar and dissimilar impulsiveness groups.

Apparatus: Two identical performance modules, 5 inches x 5 inches x 7 inches were constructed for use by the partners performing a Prisoner's Dilemma task. Each had a ready light mounted between two response buttons and four display lights which signaled to the



partners the outcome of each trial. When the ready light was on, each subject (Subject A and B) was to depress either response button 1 or response button 2 within ten seconds. Fifteen seconds after the ready light had come on the outcome of the trial was displayed to each subject via one of the four display lights. These four lights corresponded to the four possible response outcomes: A1B1, A1B2, A2B1, A2B2. Each of these outcomes was associated with a certain payoff according to the traditional Prisoner's Dilemma payoff matrix and identified to the subjects in terms of money he and his partner gained or lost. When the outcome was A1B1, the light labeled "you win 5¢, he wins 5¢" was illuminated; when the response outcome was A2B2, the light labeled "you lose 5¢, he loses 5¢" was illuminated. If subject A depressed button 1 and subject B depressed button 2, A1B2 outcome, subject A lost 10¢ and subject B won 10¢. Conversely a A2B1 response was followed by the illumination of the light labeled "you win 10¢, he loses 10¢."

The subjects' responses and response latencies were recorded on digital magnetic tape as were second by second measures of heart rate and basal skin resistance and galvanic skin responses. Basal skin resistance was later transformed to skin conductance by a general purpose computer.

Procedure: Upon arriving in the laboratory the subject was asked to complete an adjective checklist (Taub and Berger, 1974) and was then briefed on the general procedure of the experiment as to skin conductance and ECG electrodes. The subject was placed in a sound-attenuated room with the PD module and written instructions for the PD test were read and explained to him.

Instructions: Neither partner knew about the other member of the pair; he was told he was performing against "a random response generator." After one session of thirty trials, the participants were given a rest period. During this period both subjects were told about their partner and the two were allowed to communicate for three minutes via an intercom system. They were not allowed to discuss their mutual strategy for the succeeding period of the PD test. This verbal exchange was monitored and recorded. Then an additional thirty trials were performed with each subject aware of the identity of his partner. At the conclusion of the sixty PD trials the electrodes were removed from the subject and he was asked to complete another

adjective checklist, the Eysenck Personality Inventory (Eysenck and Eysenck, 1968), nurturance and preference scales of the Edwards Personal Preference Inventory (Edwards, 1959) and the Internal/External Scale (Rotter, 1966).

## Results

Performance: The performance measures taken during this study were a measure of reaction time accurate to one-tenth of a second and the response made on each trial--i.e., whether the subject made a cooperative, Type 1 response, or a noncooperative, Type 2 response, on his module. Analysis of the Type 1 versus Type 2 responses indicates that the majority of these subjects adopted a competitive attitude towards the task. A total of 26 blocks of trials out of 164 could be categorized as cooperative responses. Of the 82 subjects 14 responded more often in a cooperative manner than in a noncooperative manner in the first 30 trials and 12 responded more often in a cooperative than in the noncooperative manner in the second block of 30 trials. The ratio of cooperative to noncooperative responses was analyzed by sex and impulsivity pairings. Table I shows the mean and standard deviation values of this ratio for each type pair. The differences between the various sex and impulsivity type pairs was not significant ( $F = 1.04$ ;  $df = 9, 144$ ;  $p > .10$ ). There was, however, a significant increase in cooperation for the second block of 30 trials ( $F = 1.948$ ;  $df = 1, 144$ ;  $p < .05$ ). Since the amount of money each participant received was directly related to the number of cooperative outcomes (A1, B1) and since no differences existed between groups for that measure of cooperativeness, it was not surprising that there was no difference in amount of money paid to the subjects related to their sex or impulsivity group membership (all  $F < 1$  values).

Table II shows the reaction time data. As noted, the female subjects tended to respond more quickly than their male counterparts. This result is interesting but uninterpretable in view of the lack of emphasis on speed of response in the instructions.

Physiology: The data shown in Table III indicates no differences between cooperative and noncooperative subjects on heart rate, skin conductance or galvanic skin response measures. There were differences attributable to the sex factor and to the experimental manipulations between blocks of trials. Table IV shows the mean physiology values for



the sex and impulsivity groups. Heart rate was significantly different for males and females, females having the higher average rate ( $F = 5.99$ ;  $df = 3, 410$ ;  $p < .01$ ).

The changes in physiological responses from trial block I to trial block II is indicated in Table V. These values suggest habituation except for the skin conductance increase on trial II. The differences between trials are significant for all physiological measures (Heart rate:  $F = 6.971$ ;  $df = 1, 78$ ;  $p < .01$ ; Skin conductance:  $F = 10.826$ ;  $df = 1, 78$ ;  $p < .01$ ; Galvanic skin response number:  $F = 11.623$ ;  $df = 1, 78$ ;  $p < .01$ ; Galvanic skin response amplitude:  $F = 17.926$ ;  $df = 1, 78$ ;  $p < .01$ ). The values for physiological responses within each block of thirty trials are suggestive of habituation for skin conductance, but heart rate shows a pattern of elevation at both the initiation of the trial blocks and at the termination. This may be an anticipation effect.

Personality: In addition to the impulsivity scores which were used for selection and served as one factor in some additional analyses, several other personality tests were administered. Table VI lists the intercorrelations between these test scores and measures of performance. The only significant correlation was between the Barratt Impulsiveness Scale and the number of type II or uncooperative responses made by each participant.

Table VII shows the values of moods reported by participants before and after the experiment. Although these mood scales did not correlate significantly with performance, they did vary significantly between groups and from before to after the experiment. Anxiety was reported least by the low impulsive male group of subjects ( $F = 5.08$ ;  $df = 1, 156$ ;  $p < .05$ ). All groups reported less anxiety following the experiment than before ( $F = 10.514$ ;  $df = 1, 156$ ;  $p < .01$ ). Both sex and impulsiveness were significant factors for the reported level of hostility ( $F$  (sex) = 8.41;  $F$  (imp) = 11.86;  $df = 1, 156$ ;  $p < .01$ ). High impulsive subjects and males tended to report feeling more hostile than did low impulsive subjects or females. There was no significant change in this measure from beginning to post testing. High impulsive subjects also tended to report being more depressed than low impulsive subjects ( $F = 6.15$ ;  $df = 1, 156$ ;  $p < .05$ ). This was stable across both test administrations. The reports of depression are in apparent contrast to the reported higher cheerfulness of high impulsive subjects

( $F = 9.626$ ;  $df = 1, 156$ ;  $p < .01$ ). The significant interaction of sex and impulsivity ( $F = 4.66$ ;  $df = 1, 156$ ;  $p < .05$ ) indicates that this effect is due to the high impulsive female groups higher cheerfulness rating.

Interaction: The period of conversation between blocks of trials was limited to three minutes and to non-task related topics. For this reason the types of interactions were insufficiently varied to be amenable to parametric analysis. In general, all interactions were positive or neutral in tone.

The non-independence of these two person responses is demonstrated best by the results of attempted regression equation development. Although sex and impulsivity were relevant factors to other variables, they did not account for a significant portion of the variance in the type of responses made in these trials. The most significant predictor of noncooperative responses was the number of cooperative responses made by a subject's partner ( $F = 17.528$ ;  $df = 1, 80$ ;  $p < .01$ ). These two measures, cooperative responses by one's partner and noncooperative responses by the subject, were negatively correlated ( $r = -.435$ ). This result may be interpreted as indicating a dyad attitude toward competition or cooperation is as important as the characteristics of either person alone.

In addition, Table VII shows the correlations between the mood scales and response choices. Only the relationship between the number of uncooperative responses and cheerfulness measured after the experiment was significant.

### Summary and Conclusions

The hypothesis that impulsivity is related to response style in the Prisoner's Dilemma task was partially supported by the correlation between the Barratt Impulsiveness Scale scores and number of noncooperative responses. This effect was not strong enough to produce significant differences in ANOVA's of the response measures.

The physiological response measures were not significantly affected by whether Ss were more or less cooperative than the average. This result is clouded by the generally competitive style adopted by most Ss.

The mood of these Ss was not significantly related to response styles.

The limited communication permitted between blocks of trials was apparently enough to increase the cooperativeness of Ss significantly (see Table I). Additional communication might have shown the differential effects of similar and dissimilar pairing by sex and/or personality dimensions, but this must await further study.



TABLE I

Ratio of Cooperative to Noncooperative Responses  
for Sex and Impulsivity Pairings

	Trial I*		Trial II	
	Ratio	S. D.	Ratio	S. D.
1. HiM/HiF	.431	.277	2.214	3.484
2. HiM/LoF	.852	1.010	.329	.384
3. HiM/LoM	.554	.350	1.913	3.143
4. HiM/HiM	.650	.481	.798	.836
5. HiF/LoF	.673	.383	.620	.489
6. HiF/HiF	.662	.398	.754	.394
7. HiF/LoM	.316	.168	.872	.639
8. LoF/LoF	.668	.541	.468	.322
9. LoM/LoM	.518	.404	.255	.238
10. LoM/LoF	.667	.648	.398	.302

\*Trials I and II were significantly different ( $F = 1.948$ ,  $df = 1, 144$ ,  $p < .05$ )



TABLE II

Reaction Time Means for Sex and Impulsivity Groups  
First 30 Trials and Second 30 Trials

	Trial I		Trial II	
	RT	RT SD	RT	RT SD
Females*				
High Impulsive	1.89	.944	1.70	.825
Low Impulsive	2.05	1.083	1.80	.933
Males				
High Impulsive	2.34	.780	2.20	1.102
Low Impulsive	2.31	1.144	2.12	.986

\*Females were significantly faster in response times ( $F = 5.67$ ;  $df = 1, 144$ ;  $p < .05$ ) but no significant difference exists between impulsivity levels ( $F < 1$ ) or between blocks of trials ( $F = 1.398$ ,  $p > .10$ ). Also no significant interaction was found between these three factors.

TABLE III

Physiological Responses  
of Cooperative and Noncooperative Subjects\*

	Cooperative				Noncooperative			
	Trial I		Trial II		Trial I		Trial II	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HR	80.12	12.70	76.34	12.63	79.72	13.40	78.14	11.58
SC	22.90	14.65	25.64	18.65	19.68	12.53	22.12	12.88
GSR No.	2.06	.98	1.45	.70	2.09	1.30	1.49	.91
GSR Amp.	2.01	2.33	.60	.34	1.74	2.22	.76	.77

\*Subjects categorized on the basis of a dichotomy at the overall mean value. No significant differences were found between cooperative and noncooperative groups.

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TABLE IV

Physiological Responses of Sex-Impulsivity Groups

	HR	SC	GSR Amp.	GSR No.
High Male	73.57	22.9	1.135	1.60
High Female	83.06	20.5	1.032	1.48
Low Male	72.96	25.7	.625	1.76
Low Female	83.25	16.8	1.539	1.41



TABLE V

## Physiological Values for Trial Blocks

	Trial I	Trial II
HR	78.93	77.49
SC	20.59	22.06
GSR No.	1.86	1.25
GSR Amp.	1.69	.60

TABLE VI

## Correlations of Personality Measures and Performance

	Amount Won	No. of Coop. Responses	No. of Noncoop. Responses (overall)
BIS	.0501	-.1056	.2037*
ES	-.0381	-.1551	.1421
E	.0136	-.1652	.1589
N	.0165	-.0513	.0481
L	-.0751	.0151	-.0440
NURT.	.0487	.0843	-.0116
SUC.	.0545	.0484	.0054
I-E.	.1176	-.1267	.0329

\*Significant at  $p < .01$

TABLE VII

## Mood Reports by Sex and Impulsiveness Groups

		<u>Pre</u>			
		Anxiety <sup>3, 4</sup>	Hostility <sup>1, 2</sup>	Depression <sup>1</sup>	Cheerfulness <sup>1, 4</sup>
Hi Male	$\bar{X}$	5.952	5.952	4.238	11.762
	SD	4.477	5.509	4.668	3.434
Hi Female	$\bar{X}$	5.050	4.500	3.150	12.950
	SD	4.298	5.286	3.297	4.628
Lo Male	$\bar{X}$	3.190	3.095	1.762	11.286
	SD	3.060	4.538	2.862	2.473
Lo Female	$\bar{X}$	3.750	1.700	2.100	10.500
	SD	4.178	2.408	2.382	3.859
		<u>Post</u>			
Hi Male	$\bar{X}$	4.286	7.143	3.571	11.333
	SD	4.573	6.836	4.728	3.851
Hi Female	$\bar{X}$	2.900	3.400	1.900	13.300
	SD	4.179	4.706	2.845	3.625
Lo Male	$\bar{X}$	2.095	4.000	2.190	10.762
	SD	2.982	4.572	2.421	3.015
Lo Female	$\bar{X}$	2.750	2.000	1.700	9.900
	SD	3.075	1.947	1.809	2.900

<sup>1</sup>Impulsiveness factor significant<sup>2</sup>Sex factor significant<sup>3</sup>Pre/Post difference significant<sup>4</sup>Impulsiveness-Sex interaction significant



TABLE VIII

## Correlations of Mood Scales and Response Choices

	No. of Cooperative Responses	No. of Noncooperative Responses
Mood Pre Experiment		
Anxiety	-.0853	.0516
Cheerfulness	.0241	-.0576
Depression	-.0121	.0161
Hostility	-.0214	.0453
Mood Post Experiment		
Anxiety	.0605	.0859
Cheerfulness	.0293	-.1926*
Depression	.0433	.1299
Hostility	.0730	.0517

\*p &lt; .05

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## POST PD QUESTIONNAIRE

1. Why did you volunteer for this experiment? Circle one or more:  
Interested                      Needed money                      For Fun  
For Adventure                      Why Not?                      Other \_\_\_\_\_
2. Did you have trouble finding  
1) Baylor - Yes No  
2) The right room - Yes No  
3) A parking place - Yes No
3. Did you know (or suspect) that you had a human partner from the beginning of the experiment, i.e. during the first 30 trials?
4. What tipped you off?
5. Do you think your partner was cooperative?
6. Do you think your partner was competitive?
7. (a). What effect did the knowledge at the sex of the other subject have on your responses during the task?  
(b). Would you rather have had a male or a female as the other subject in the experiment?
8. (a). In general, did you like the experiment?  
(b). Were the electrodes uncomfortable? Explain  
(c). Did you like the decision task itself?  
(d). Do you think the stakes (win or lose 5¢, 10¢) were too high or too low or about right?
9. What was your strategy during the experiment?
10. Did the fact that this study was conducted through the Psychiatry dept. have any effect on your performance on the experimental task? If so, what?
11. How much do you need the money you got from this experiment? Circle one.  
7      6      5      4      3      2      1  
A lot                      So-So                      Don't Need
12. Do you think your partner won more or less than you?

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## Mood Scale

Describe your present mood with your first reaction to each of the following words. Do not be concerned about remembering responses to previous items in the list; just respond to each word individually.

	NOT AT ALL	A LITTLE	MODER- ATELY	QUITE A BIT	EX- TREMELY
friendly	0	0	0	0	0
weary	0	0	0	0	0
lonely	0	0	0	0	0
satisfied	0	0	0	0	0
worried -----	0	0	0	0	0
tense	0	0	0	0	0
lively	0	0	0	0	0
dependable	0	0	0	0	0
sarcastic	0	0	0	0	0
truthful -----	0	0	0	0	0
annoyed	0	0	0	0	0
warm-hearted	0	0	0	0	0
washed-out	0	0	0	0	0
depressed	0	0	0	0	0
forgetful -----	0	0	0	0	0
carefree	0	0	0	0	0
jittery	0	0	0	0	0
active	0	0	0	0	0
alert	0	0	0	0	0
able to work -----	0	0	0	0	0
nausea	0	0	0	0	0
grouchy	0	0	0	0	0
sociable	0	0	0	0	0
muddled	0	0	0	0	0
worn-out -----	0	0	0	0	0
sad	0	0	0	0	0
tired	0	0	0	0	0
irritable	0	0	0	0	0
ashamed	0	0	0	0	0
on edge -----	0	0	0	0	0
cheerful	0	0	0	0	0
slowed-down	0	0	0	0	0
good natured	0	0	0	0	0

	NOT AT ALL	A LITTLE	MODER- ATELY	QUITE A BIT	EX- TREMELY
blue	0	0	0	0	0
headache	0	0	0	0	0
vigorous	0	0	0	0	0
nervous	0	0	0	0	0
bushed -----	0	0	0	0	0
angry	0	0	0	0	0
spiteful	0	0	0	0	0
resentful	0	0	0	0	0
efficient	0	0	0	0	0
foggy -----	0	0	0	0	0
kind	0	0	0	0	0
able to concentrate	0	0	0	0	0
shaky	0	0	0	0	0
pleasant	0	0	0	0	0
sleepy -----	0	0	0	0	0
fatigued	0	0	0	0	0
happy	0	0	0	0	0
bad-tempered	0	0	0	0	0
loss of appetite	0	0	0	0	0
discouraged -----	0	0	0	0	0
confused	0	0	0	0	0
well-rested	0	0	0	0	0
full of pep	0	0	0	0	0



# EYSENCK PERSONALITY INVENTORY

## FORM B

By **H. J. Eysenck**  
and **Sybil B. G. Eysenck**

Name \_\_\_\_\_ Age \_\_\_\_\_ Sex \_\_\_\_\_

Grade or Occupation \_\_\_\_\_ Date \_\_\_\_\_

School or Firm \_\_\_\_\_ Marital Status \_\_\_\_\_

## INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."

Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

Section of Answer Column Correctly Marked	
Yes	No
<input type="checkbox"/>	<input type="checkbox"/>
Yes	No
<input type="checkbox"/>	<input type="checkbox"/>

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1. Do you like plenty of excitement and bustle around you? Yes No
2. Have you often got a restless feeling that you want something but do not know what? Yes No
3. Do you nearly always have a "ready answer" when people talk to you? Yes No
4. Do you sometimes feel happy, sometimes sad, without any real reason? Yes No
5. Do you usually stay in the background at parties and "get-togethers"? Yes No
6. As a child did you always do as you were told immediately and without grumbling? Yes No
7. Do you sometimes sulk? Yes No
8. When you are drawn into a quarrel, do you prefer to "have it out" to being silent hoping things will blow over? Yes No
9. Are you moody? Yes No
10. Do you like mixing with people? Yes No
11. Have you often lost sleep over your worries? Yes No
12. Do you sometimes get cross? Yes No
13. Would you call yourself happy-go-lucky? Yes No
14. Do you often make up your mind too late? Yes No
15. Do you like working alone? Yes No
16. Have you often felt listless and tired for no good reason? Yes No
17. Are you rather lively? Yes No
18. Do you sometimes laugh at a dirty joke? Yes No
19. Do you often feel "fed-up"? Yes No
20. Do you feel uncomfortable in anything but everyday clothes? Yes No
21. Does your mind often wander when you are trying to attend closely to something? Yes No
22. Can you put your thoughts into words quickly? Yes No
23. Are you often "lost in thought"? Yes No
24. Are you completely free from prejudices of any kind? Yes No
25. Do you like practical jokes? Yes No
26. Do you often think of your past? Yes No
27. Do you very much like good food? Yes No
28. When you get annoyed do you need someone friendly to talk to about it? Yes No
29. Do you mind selling things or asking people for money for some good cause? Yes No
30. Do you sometimes boast a little? Yes No

31. Are you touchy about some things? Yes No
32. Would you rather be at home on your own than go to a boring party? Yes No
33. Do you sometimes get so restless that you cannot sit long in a chair? Yes No
34. Do you like planning things carefully, well ahead of time? Yes No
35. Do you have dizzy spells? Yes No
36. Do you always answer a personal letter as soon as you can after you have read it? Yes No
37. Can you usually do things better by figuring them out alone than by talking to others about it? Yes No
38. Do you ever get short of breath without having done heavy work? Yes No
39. Are you an easy-going person, not generally bothered about having everything "just-so"? Yes No
40. Do you suffer from "nerves"? Yes No
41. Would you rather plan things than do things? Yes No
42. Do you sometimes put off until tomorrow what you ought to do today? Yes No
43. Do you get nervous in places like elevators, trains or tunnels? Yes No
44. When you make new friends, is it usually you who makes the first move, or does the inviting? Yes No
45. Do you get very bad headaches? Yes No
46. Do you generally feel that things will sort themselves out and come right in the end somehow? Yes No
47. Do you find it hard to fall asleep at bedtime? Yes No
48. Have you sometimes told lies in your life? Yes No
49. Do you sometimes say the first thing that comes into your head? Yes No
50. Do you worry too long after an embarrassing experience? Yes No
51. Do you usually keep "yourself to yourself" except with very close friends? Yes No
52. Do you often get into a jam because you do things without thinking? Yes No
53. Do you like cracking jokes and telling funny stories to your friends? Yes No
54. Would you rather win, than lose a game? Yes No
55. Do you often feel self-conscious when you are with superiors? Yes No
56. When the odds are against you, do you still usually think it worth taking a chance? Yes No
57. Do you often get "butterflies in your stomach" before an important occasion? Yes No

## **EPPI S-N Scale**

### **INSTRUCTORS FOR THE S-N SCALE**

The following 54 pairs of items are statements about things you may or may not like; about ways in which you may or may not feel. They are statements of preference.

You are to choose the statement that is most characteristic of what you like or how you feel. If both statements describe how you feel, choose the one which is most characteristic of your feelings. If neither statement accurately describes how you feel, then you should choose the one which you consider to be less inaccurate.

Your choice in each instance should be in terms of what you like and how you feel at the present time, and not in terms of what you think you should like or how you think you should feel. This is not a test. There are no right or wrong answers. Your choice should be a description of your own personal likes and feelings.



1. a. I like to accomplish tasks that others recognize as requiring skill and effort.  
b. I like my friends to encourage me when I meet with failure.
2. a. When planning something, I like to get suggestions from other people whose opinions I respect.  
b. I like my friends to treat me kindly.
3. a. I like to have my life so arranged that it runs smoothly and without much change in my plans.  
b. I like my friends to feel sorry for me when I am sick.
4. a. I like to be the center of attention in a group.  
b. I like my friends to make a fuss over me when I am hurt or sick.
5. a. I like to avoid situations where I am expected to do things in a conventional way.  
b. I like my friends to sympathize with me and to cheer me up when I am depressed.
6. a. I like to do my very best in whatever I undertake.  
b. I like to help other people who are less fortunate than I am.
7. a. I like to find out what great men have thought about various problems in which I am interested.  
b. I like to be generous with my friends.
8. a. I like to make a plan before starting in to do something difficult.  
b. I like to do small favors for my friends.
9. a. I like to tell other people about adventures and strange things that have happened to me.  
b. I like my friends to confide in me and to tell me their troubles.
10. a. I like to say what I think about things.  
b. I like to forgive my friends who may sometimes hurt me.
11. a. I like my friends to encourage me when I meet with failure.  
b. I like to be successful in things undertaken.
12. a. I like my friends to be sympathetic and understanding when I have problems.  
b. I like to accept the leadership of people I admire.

- 13. a. I like my friends to treat me kindly.  
b. I like to have my work organized and planned before beginning it.
- 14. a. I like my friends to make a fuss over me when I am hurt or sick.  
b. I like to talk about my achievements.
- 15. a. I like my friends to feel sorry for me when I am sick.  
b. I like to avoid situations where I am expected to do things in a conventional way.
- 16. a. I like my friends to help me when I am in trouble.  
b. I like to do things for my friends.
- 17. a. I like my friends to do many small favors for me cheerfully.  
b. I like to judge people by why they do something--not by what they actually do.
- 18. a. I like to form new friendships.  
b. I like my friends to help me when I am in trouble.
- 19. a. I like to judge people by why they do something--not by what they actually do.  
b. I like my friends to show a great deal of affection toward me.
- 20. a. I like to be called upon to settle arguments and disputes between others.  
b. I like my friends to do many small favors for me cheerfully.
- 21. a. I feel that I should confess the things that I have done that I regard as wrong.  
b. I like my friends to sympathize with me and to cheer me up when I am depressed.
- 22. a. I like my friends to sympathize with me and to cheer me up when I am depressed.  
b. When with a group of people, I like to make the decisions about what we are going to do.
- 23. a. I like my friends to feel sorry for me when I am sick.  
b. I feel better when I give in and avoid a fight, than I would if I tried to have my own way.
- 24. a. I like to participate in groups in which the members have warm friendly feelings toward one another.  
b. I like to help my friends when they are in trouble.

- 25. a. I like to analyze my own motives and feelings.  
b. I like to sympathize with my friends when they are hurt or sick.
- 26. a. I like my friends to help me when I am in trouble.  
b. I like to treat other people with kindness and sympathy.
- 27. a. I like to be one of the leaders in the organizations and groups to which I belong.  
b. I like to sympathize with my friends when they are hurt or sick.
- 28. a. I feel that the pain and misery that I have suffered has done me more good than harm.  
b. I like to show a great deal of affection toward my friends.
- 29. a. I like my friends to be sympathetic and understanding when I have problems.  
b. I like to meet new people.
- 30. a. I like my friends to do many small favors for me cheerfully.  
b. I like to stay up late working in order to get a job done.
- 31. a. I like my friends to show a great deal of affection toward me.  
b. I like to become sexually excited.
- 32. a. I like my friends to make a fuss over me when I am hurt or sick.  
b. I feel like blaming others when things go wrong for me.
- 33. a. I like to help my friends when they are in trouble.  
b. I like to do my very best in whatever I undertake.
- 34. a. I like to do small favors for my friends.  
b. When planning something, I like to get suggestions from other people whose opinions I respect.
- 35. a. I like to be generous with my friends.  
b. I like to make a plan before starting in to do something difficult.
- 36. a. I like to show a great deal of affection toward my friends.  
b. I like to say things that are regarded as witty and clever by other people.
- 37. a. I like to sympathize with my friends when they are hurt or sick.  
b. I like to say what I think about things.
- 38. a. I like to help my friends when they are in trouble.  
b. I like to be loyal to my friends.



- a. I like to be generous with my friends.
  - b. I like to observe how another individual feels in a given situation.
40. a. I like to forgive my friends who may sometimes hurt me.
- b. I like my friends to encourage me when I meet with failure.
41. a. I like to experiment and to try new things.
- b. I like my friends to be sympathetic and understanding when I have problems.
42. a. I like to keep working at a puzzle or problem until it is solved.
- b. I like my friends to treat me kindly.
43. a. I like to be regarded as physically attractive by those of the opposite sex.
- b. I like my friends to show a great deal of affection toward me.
44. a. I feel like criticizing someone publicly if he deserves it.
- b. I like my friends to make a fuss over me when I am hurt or sick.
45. a. I like to show a great deal of affection toward my friends.
- b. I like to be regarded by others as a leader.
46. a. I like to show a great deal of affection toward my friends.
- b. When things go wrong for me, I feel that I am more to blame than anyone else.
47. a. I like to do new and different things.
- b. I like to treat other people with kindness and sympathy.
48. a. When I have some assignment to do, I like to start in and keep working on it until it is completed.
- b. I like to help other people who are less fortunate than I am.
49. a. I like to engage in social activities with persons of the opposite sex.
- b. I like to forgive my friends who may sometimes hurt me.
50. a. I like to attack points of view that are contrary to mine.
- b. I like my friends to confide in me and to tell me their troubles.
51. a. I like to treat other people with kindness and sympathy.
- b. I like to travel and to see the country.
52. a. I like to help other people who are less fortunate than I am.
- b. I like to finish any job or task that I begin.

- 53. a. I like to do small favors for my friends.  
b. I like to engage in social activities with persons of the opposite sex.
- 54. a. I like my friends to confide in me and to tell me their troubles.  
b. I like to read newspaper accounts of murders and other forms of violence.

#### INSTRUCTORS FOR THE I-E SCALE

This is a questionnaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you're concerned. Be sure to select the one you actually believe to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief; obviously there are no right or wrong answers.

Please answer these items carefully but do not spend too much time on any one item. Be sure to find an answer for every choice.

In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item independently when making your choice; do not be influenced by your previous choices.



- 2
1. a. Children get into trouble because their parents punish them too much.  
b. The trouble with most children nowadays is that their parents are too easy with them.
  2. a. Many of the unhappy things in people's lives are partly due to bad luck.  
b. People's misfortunes result from the mistakes they make.
  3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.  
b. There will always be wars, no matter how hard people try to prevent them.
  4. a. In the long run people get the respect they deserve in this world.  
b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.
  5. a. The idea that teachers are unfair to students is nonsense.  
b. Most students don't realize the extent to which their grades are influenced by accidental happenings.
  6. a. Without the right breaks one cannot be an effective leader.  
b. Capable people who fail to become leaders have not taken advantage of their opportunities.
  7. a. No matter how hard you try some people just don't like you.  
b. People who can't get others to like them don't understand how to get along with others.
  8. a. Heredity plays the major role in determining one's personality.  
b. It is one's experiences in life which determine what they're like.
  9. a. I have often found that what is going to happen will happen.  
b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.
  10. a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.  
b. Many times exam questions tend to be so unrelated to course work that studying is really useless.
  11. a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.  
b. Getting a good job depends mainly on being in the right place at the right time.



12. a. The average citizen can have an influence in government decisions.  
b. This world is run by the few people in power, and there is not much the little guy can do about it.
13. a. When I make plans, I am almost certain that I can make them work.  
b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.
14. a. There are certain people who are just no good.  
b. There is some good in everybody.
15. a. In my case getting what I want has little or nothing to do with luck.  
b. Many times we might just as well decide what to do by flipping a coin.
16. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.  
b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.
17. a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.  
b. By taking an active part in political and social affairs the people can control world events.
18. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.  
b. There really is no such thing as "luck."
19. a. One should always be willing to admit mistakes.  
b. It is usually best to cover up one's mistakes.
20. a. It is hard to know whether or not a person really likes you.  
b. How many friends you have depends upon how nice a person you are.
21. a. In the long run the bad things that happen to us are balanced by the good ones.  
b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.
22. a. With enough effort we can wipe out political corruption.  
b. It is difficult for people to have much control over the things politicians do in office.

23. a. Sometimes I can't understand how teachers arrive at the grades they give.  
b. There is a direct connection between how hard I study and the grades I get.
24. a. A good leader expects people to decide for themselves what their jobs are.  
b. A good leader makes it clear to everybody what their jobs are.
25. a. Many times I feel that I have little influence over the things that happen to me.  
b. It is impossible for me to believe that chance or luck plays an important role in my life.
26. a. People are lonely because they don't try to be friendly.  
b. There's not much use in trying too hard to please people, if they like you, they like you.
27. a. There is too much emphasis on athletics in high school.  
b. Team sports are an excellent way to build character.
28. a. What happens to me is my own doing.  
b. Sometimes I feel that I don't have enough control over the direction my life is taking.
29. a. Most of the time I can't understand why politicians behave the way they do.  
b. In the long run the people are responsible for bad government on a national as well as on a local level.

**CONFIDENTIAL**

**Psychological Screening Test**

**I. Permission**

I hereby agree to complete this screening test which I understand is part of a selection procedure for subjects for psychological and physiological studies to be conducted by Robert Roessler, M. D. I understand the results will be confidential and the test will be destroyed as soon as the selection of subjects has been completed.

If I am selected, the nature of the experiment will be further explained to me and if I agree to participate, my consent for further experimentation will be obtained.

Signed: \_\_\_\_\_ Age \_\_\_\_\_ Sex \_\_\_\_\_  
(subject)

Address: \_\_\_\_\_ Telephone No. \_\_\_\_\_

Date: \_\_\_\_\_

**II. Instructions**

**Part A:**

Here are some statements and questions regarding the way you behave, feel, and act. After each question is a space for answering "TRUE" or "FALSE".

Try to decide whether "TRUE" or "FALSE" represents your usual way of acting or feeling. Then put a cross in the space under the column headed "TRUE" or "FALSE".

**Part B:**

This section contains 48 statements about the way you act and think. You are to indicate whether the statement applies to you "Usually", "Often", "Occasionally", or "Rarely or Never" by marking an X in the appropriate column.

Work quickly, and don't spend too much time over any question; we want your first reaction, not a long, drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions.

Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.



Part A:

	<u>TRUE</u>	<u>FALSE</u>
1. During the past few years I have been well most of the time.	1. _____	_____
2. I am in just as good physical health as most of my friends.	2. _____	_____
3. I have never had a fainting spell.	3. _____	_____
4. I feel weak all over much of the time.	4. _____	_____
5. My hands have not become clumsy or awkward.	5. _____	_____
6. I have a cough most of the time.	6. _____	_____
7. I have a good appetite.	7. _____	_____
8. I have diarrhea once a month or more.	8. _____	_____
9. At times I hear so well it bothers me.	9. _____	_____
10. I seldom worry about my health.	10. _____	_____
11. My sleep is fitful and disturbed.	11. _____	_____
12. I feel unable to tell anyone all about myself.	12. _____	_____
13. I feel sympathetic towards people who tend to hang on to their grief and troubles.	13. _____	_____
14. I brood a great deal.	14. _____	_____
15. I frequently find myself worrying about something.	15. _____	_____
16. I have met problems so full of possibilities that I have been unable to make up my mind about them.	16. _____	_____
17. I get mad easily and then get over it soon.	17. _____	_____
18. When I leave home, I do not worry about whether the door is locked and the windows closed.	18. _____	_____
19. Sometimes some unimportant thought will run through my mind and bother me for days.	19. _____	_____
20. Often I cross the street in order not to meet someone I see.	20. _____	_____
21. I dream frequently about things that are best kept to myself.	21. _____	_____
22. I go to church almost every week.	22. _____	_____
23. I pray several times every week.	23. _____	_____
24. Christ performed miracles such as changing water into wine.	24. _____	_____
25. Everything is turning out just like the prophets of the Bible said it would.	25. _____	_____
26. I have had some very unusual religious experiences.	26. _____	_____
27. I believe my sins are unpardonable.	27. _____	_____
28. I would certainly enjoy beating a crook at his own game.	28. _____	_____
29. When I get bored, I like to stir up some excitement.	29. _____	_____
30. I do many things which I regret afterwards (I regret things more or more often than others seem to).	30. _____	_____
31. I can be friendly with people who do things which I consider wrong.	31. _____	_____
32. Some people are so bossy that I feel like doing the opposite of what they request, even though I know they are right.	32. _____	_____
33. I like to flirt.	33. _____	_____
34. I am attracted by members of the opposite sex.	34. _____	_____
35. I never attend a sexy show if I can avoid it.	35. _____	_____
36. I like to talk about sex.	36. _____	_____
37. I do not like to see women smoke.	37. _____	_____
38. Sometimes I enjoy hurting persons I love.	38. _____	_____

TRUE FALSE

- |     |  |     |       |       |
|-----|--|-----|-------|-------|
| 39. | I have had very peculiar and strange experiences.  | 39. | _____ | _____ |
| 40. | I have strange and peculiar thoughts.  | 40. | _____ | _____ |
| 41. | I have had blank spells in which my activities were interrupted and I did not know what was going on around me.      | 41. | _____ | _____ |
| 42. | When I am with people, I am bothered by hearing very queer things.   | 42. | _____ | _____ |
| 43. | At times I have fits of laughing and crying that I cannot control.   | 43. | _____ | _____ |
| 44. | I have had no difficulty in keeping my balance in walking.   | 44. | _____ | _____ |
| 45. | Parts of my body often have feelings like burning, tingling, crawling, or like "going to sleep".                     | 45. | _____ | _____ |
| 46. | My skin seems to be unusually sensitive to touch.  | 46. | _____ | _____ |
| 47. | My plans have frequently seemed so full of difficulties that I have had to give them up.                             | 47. | _____ | _____ |
| 48. | I am easily downed in an argument.   | 48. | _____ | _____ |
| 49. | I find it hard to keep my mind on a task or job.   | 49. | _____ | _____ |
| 50. | My way of doing things is apt to be misunderstood by others.   | 50. | _____ | _____ |
| 51. | I sometimes feel that I am about to go to pieces.  | 51. | _____ | _____ |
| 52. | I feel tired a good deal of the time.  | 52. | _____ | _____ |
| 53. | If I were an artist, I would like to draw flowers.   | 53. | _____ | _____ |
| 54. | If I were an artist, I would like to draw children.  | 54. | _____ | _____ |
| 55. | I like collecting flowers or growing house plants.   | 55. | _____ | _____ |
| 56. | I like to cook.  | 56. | _____ | _____ |
| 57. | When someone says silly or ignorant things about something I know, I try to set him right.                           | 57. | _____ | _____ |
| 58. | I am not afraid of fire.   | 58. | _____ | _____ |
| 59. | I am made nervous by certain animals.  | 59. | _____ | _____ |
| 60. | Dirt frightens or disgusts me.   | 60. | _____ | _____ |
| 61. | I am afraid of finding myself in a closet or small closed place.   | 61. | _____ | _____ |
| 62. | I have often been frightened in the middle of the night.   | 62. | _____ | _____ |
| 63. | I like science.  | 63. | _____ | _____ |
| 64. | I think Lincoln was greater than Washington.   | 64. | _____ | _____ |
| 65. | I very much like horseback riding.   | 65. | _____ | _____ |
| 66. | The man who had most to do with me when I was a child (such as my father, stepfather, etc.) was very strict with me. | 66. | _____ | _____ |
| 67. | One or more members of my family is very nervous.  | 67. | _____ | _____ |
| 68. | In my home we have always had the ordinary necessities (such as enough food, clothing, etc.).                        | 68. | _____ | _____ |



# Adjective Checklist

## Part B:

		RARELY OR NEVER	OCCASIONALLY	OFTEN	USUALLY
1.	I like excitement.....	0	0	0	0
2.	I answer quickly.....	0	0	0	0
3.	I am restrained.....	0	0	0	0
4.	I like to watch fires.....	0	0	0	0
5.	I write neatly.....	0	0	0	0
6.	I am free and spontaneous.....	0	0	0	0
7.	I am careful.....	0	0	0	0
8.	I am restless at lectures.....	0	0	0	0
9.	I eat slowly.....	0	0	0	0
10.	I buy things which I don't need.....	0	0	0	0
11.	I like new situations.....	0	0	0	0
12.	I like variety in my work.....	0	0	0	0
13.	I like to read.....	0	0	0	0
14.	I shout at people.....	0	0	0	0
15.	I speak slowly and deliberately.....	0	0	0	0
16.	I like mathematics.....	0	0	0	0
17.	I am a calm thinker.....	0	0	0	0
18.	I like detailed work.....	0	0	0	0
19.	I like competition.....	0	0	0	0
20.	I walk and move fast.....	0	0	0	0
21.	I say what I feel like saying.....	0	0	0	0
22.	I am easily bored.....	0	0	0	0
23.	I throw things or bang doors.....	0	0	0	0
24.	I am a good listener.....	0	0	0	0



		RARELY OR NEVER	OCCASIONALLY	OFTEN	USUALLY
25.	I say things which I later regret.....	0	0	0	0
26.	My hands shake when doing fine tasks.....	0	0	0	0
27.	I am easily distracted.....	0	0	0	0
28.	I like to take chances.....	0	0	0	0
29.	I act on impulse.....	0	0	0	0
30.	I complete what I start.....	0	0	0	0
31.	I am serious.....	0	0	0	0
32.	I am enthusiastic.....	0	0	0	0
33.	I concentrate easily.....	0	0	0	0
34.	I take dares just for fun.....	0	0	0	0
35.	I am carefree.....	0	0	0	0
36.	I like risky situations.....	0	0	0	0
37.	I take chances.....	0	0	0	0
38.	I am patient.....	0	0	0	0
39.	I let myself "go" at a party.....	0	0	0	0
40.	I liven up dull parties.....	0	0	0	0
41.	I like golfing.....	0	0	0	0
42.	I make friends easily.....	0	0	0	0
43.	I am happy-go-lucky.....	0	0	0	0
44.	I like complex problems.....	0	0	0	0
45.	I think before I act.....	0	0	0	0
46.	I like simple approaches to life.....	0	0	0	0
47.	I change my plans.....	0	0	0	0
48.	I am impulsive.....	0	0	0	0

## Instructions for Prisoner's Dilemma Task

### SUBJECT A

You will be given five dollars which is yours to keep and another three dollars to use in this task. It is possible to gain more money or to lose some by performing the decision task I am about to describe. There will be ninety trials and on each trial you will make a choice between the two green buttons on the top of your module. When the small red ready light between the buttons comes on, either push button #1 or push button #2. When you have responded the ready light will go out, indicating your response has been recorded. Fifteen seconds after the ready light comes on the result of your response will be displayed to you via the four red lights on the front panel of your module. Now, you will notice on your panel that two performers are referred to by the letters A and B. As is marked on your module, you are A. In this experiment performer B is a programmed response generator. In an earlier experiment the other performer was a real person. Now I will explain the four lights on your panel, one of which will come on after every trial.

Suppose you choose to press button #1 and the random response equipment happens to make a #1 response also, then you each win 5¢. If you choose #1 and the equipment chooses #2, you lose 10¢ and B wins 10¢. If you choose #2 and the equipment chooses #1, then you win 10¢ and B loses 10¢.

Are there any questions?

Since you have electrodes attached to one of your hands you will need to keep that hand as still and as relaxed as possible during the experiment. Use only the alternate, free hand to push the buttons. It is very important that you do not move your wired-up hand and arm!

Now I will leave to check to be sure your electrodes are working properly. It will take about four minutes so just sit here, relax and try not to move your wired-up hand and arm. When the red ready light comes on in a few minutes the experiment is ready to begin and you should make your first response by pushing #1 or #2. Fifteen

seconds after that light appears, the result of your response will be displayed for five seconds and then the ready light will come on again.

Continue making choices each time the ready light comes on until we tell you to stop. There will be a short break after the first 30 trials.

Any more questions?



# SLEEP DEPRIVATION, PERSONALITY, AND PERFORMANCE ON A COMPLEX VIGILANCE TASK\*

by

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## Abstract

*Groups formed from subjects selected for extreme scores on the Barron Ego Strength Scale (Es) and on the Barratt Impulsiveness Scale (BIS) differed in the number of signals correctly detected in a visual monitoring task during a 72-hour sleep deprivation experiment. Subjects who scored high on the Es scale detected more signals than did normal or low Es subjects. Subjects who scored low on the BIS also performed significantly better on the vigilance task. Sleep deprivation produced substantial decrements in four performance measures. The results are discussed in relation to the effects of personality types on performance during sleep deprivation.*

## Introduction

The effects of sleep deprivation upon human performance have been studied by many investigators (Williams, et al., 1959; Wilkinson, 1968; Naitoh, et al., 1971; Hamilton, et al., 1972; Taub and Berger, 1974). These studies have been characterized by substantial individual differences. There is evidence that some of this individual variability is related to personality (Strausbaugh and Roessler, 1970). In an attempt to clarify the sources of this variability, subjects in this experiment were selected on the basis of personality variables.

Most factor-analytic studies of self-report personality measures report that two major orthogonal dimensions account for most of the variance. These dimensions are extroversion-introversion and neuroticism-ego strength. Reports have conflicted on whether introversion or extroversion is associated with better vigilance performance (Halecomb and Kirk, 1965; Shanmugam, 1965; Eysenck, 1967). Some of the inconsistent results are due to variable experimental conditions, some are the result of the personality measures employed. The Eysenck scale, the most commonly used extroversion measure, is made up of both sociability and impulsiveness items (Eysenck and Eysenck, 1963). However, the Barratt Impulsiveness Scale (BIS) is comprised exclusively of impulsiveness items. The BIS has been shown to be related to reaction times in complex tasks, variability in response latencies, and errors on a visual vigilance task (Barratt and White, 1969; Roessler, 1973). Subjects with high BIS scores made more errors and had longer response latencies than other subjects in performing perceptual-motor tasks (Barratt, 1967).

To elucidate the relationships between personality and vigilance performance, the Barron Ego Strength Scale (Barron, 1956), and the BIS were employed to select subjects in a 72-hour sleep-deprivation experiment. In a previous experiment in this laboratory, persons with high ego strength scores performed better than low ego strength subjects on a vigilance task during 24 hours of sleep deprivation (Strausbaugh and Roessler, 1970). The ego strength (Es) scale, which is highly correlated with the neuroticism scale from the Eysenck Personality Inventory, has been linked to personal resourcefulness, sociability, and broad social skills (Barron, 1956).

should therefore be well suited for prediction of performance on a sustained vigilance task under stress.

Used together to select subjects, it was hypothesized that the Es scale and the BIS would be more predictive of vigilance performance than either used alone. Since a high Es score is associated with superior performance and a high BIS score is associated with inferior performance, the performance of persons scoring high on both scales was predicted to be similar to that of subjects scoring near the mean on both measures. Similarly, those persons with low Es/low BIS scores were predicted to perform at the level of subjects with Es and BIS scores near the mean. In addition, superior performance from high Es/low BIS subjects, and inferior performance from Es/high BIS subjects was predicted. It was also predicted that there would be differential rates of performance decrement among the personality groups, with the high Es/low BIS maintaining performance best.

## Experimental Procedure

**Subjects:** Sixteen adult males, ages 18 to 33 years (mean age 24.6 years) were recruited. In recruiting subjects the formation of four groups was attempted, based on the subjects' scores on the Es scale and the BIS falling at least  $\pm 1.75$  standard deviation from the mean. However, only 6 persons were identified as low Es/low BIS of the 1,000 Ss screened, and only one of these was willing to participate in the study. Therefore, the low Es/low BIS group was replaced with a normal control group composed of Ss who were near the mean on both the ego strength and impulsiveness scales ( $N = 5$ ). Of the other three personality groups, one group was high on the ego strength scale and low on impulsiveness ( $N = 4$ ), one group was low on Es and high on BIS ( $N = 4$ ), and one group was high on both the Es measure and the BIS ( $N = 3$ ). Although six high Es/high BIS subjects volunteered, three dropped out early in the experiment. All subjects were in good physical health, were fully informed as to the nature of the experiment, signed a standard consent form, and were paid on an incremental scale for each 24-hour block of sleep deprivation. Subjects were run in groups of three and were kept active on performance tasks throughout each 6-hour period except for one-half hour devoted to eating and personal hygiene.

**Procedure:** Ss were first given one practice session on the tests which they were to perform during the experiment. When the Ss returned to the laboratory in the evening for the 3-night sleep deprivation study, they were tested for a total of 12, 6-hour sessions, for a total of 72 hours of wakefulness. Ss were then allowed to sleep overnight and upon waking were given another 6-hour test session, the recovery session. The data reported here are derived from a complex vigilance performance task.

**Vigilance Task:** The task consisted of the subjects monitoring 3 meters in a module on the table at which S was seated. The performance module consisted of a horizontal panel below an inclined panel. On a



panel was a green and a red button, the latter being closest to S. When one of the green buttons was depressed by S the corresponding meter was illuminated, allowing S to determine whether or not the needle was deflected. S was instructed that when he perceived a needle deflection he was immediately to depress the red abort button associated with the meter. Failure to depress the abort button within 1.25 seconds after the needle had deflected resulted in a 2.5 milliamperes per square centimeter shock being delivered to the calf of S's leg. Such an error in detecting the meter deflection and failing to abort defined an omission error. The time from needle deflection to depression of an abort button was defined as reaction time.

S monitored the meters in reduced ambient light by depressing the green buttons in a left to right order (interrogation). The interrogation rate was defined as the number of green buttons pressed per minute. Meter deflections were preprogrammed according to a pseudo-random schedule utilizing variable intervals between deflections. The schedule provided approximately 22 meter deflections per 5 minute period with meter deflection intervals between 9.5 and 59 sec. Since meter deflections were of only 1.4 second duration, interrogating speed was required to detect and abort within the required time.

Each vigilance session began with a 5 minute rest period followed by a 10 minute period during which S was required to monitor the 3 meter visual display. Then during the next 20 minutes S was presented a list of 25 words through earphones while monitoring the visual display. Different word lists equated for difficulty were used in each testing occurring once every 6 hours throughout the deprivation period. Another 10 minutes of visual monitoring followed, after which S was asked to recall and write down as many of the 25 words as he could remember, regardless of order of presentation. Order of the visual monitoring only and visual monitoring — word memory conditions was thus counter-balanced within subjects. S was given 10 cents for every word correctly recalled. Only the data from trials (6-hour periods) 1, 3, 5, 7, 9, 11, 12 and 13 (the recovery session) were used for analysis in order to reduce data volume.

## Results

Analyses of variance for repeated measures were performed on the various performance measures available from the vigilance task. When significant F ratios were obtained, comparisons of pairs of means were made with Duncan's multiple range test (Kirk, 1968). The performance measures will be presented separately and all analyses for each measure will be described before proceeding to the next measure. The four measures were: (1) number of signals undetected, i.e., omission errors (OE), (2) number of meters examined in a five minute interval, i.e., interrogation rate (IR), (3) number of words forgotten of the 25 words presented, i.e., word-forgetting scores (WF), and (4) average reaction times (RT) in msec for those meter deflections to which S attempted to respond. All of these measures were

subjected to analyses comparing: (1) sleep deprivation trials, (2) the four groups of subjects, (3) the 3 levels of each personality dimension, and (4) the two levels of vigilance task complexity (visual monitoring only or visual plus auditory monitoring).

**Omission Errors:** Across the sleep deprivation trials, total omission errors per five minutes showed significant increments [ $F(7,45) = 52.32, p < .01$ ]. In addition, to adjust for differences among Ss in the level of their initial performance, deviation scores were computed by averaging the score obtained on the first test session with that obtained from the recovery session (i.e., a baseline score), and subtracting that baseline average from each test session score. This also avoided negative values. This OE deviation score also showed significant increments across sleep deprivation trials [ $F(5,60) = 62.44, p < .01$ ]. Omission errors increased 59% from baseline scores to the end of the 72-hour sleep deprivation period (See Table I). Both raw and adjusted OE scores, then, revealed the sleep deprivation effect.

TABLE I: PERFORMANCE MEASURE MEANS ACROSS SLEEP-DEPRIVATION TRIALS (ALL MEASURES EXCEPT WORD-FORGETTING (WF) ARE CALCULATED PER 5-MINUTE SEGMENT OF THE VIGILANCE TASK. SCORE IN PARENTHESES IS BASELINE SCORE, I.E., MEAN OF FIRST AND RECOVERY SESSIONS)

MEASURES	HOURS OF SLEEP DEPRIVATION							
	0-6	13-18	25-30	37-42	49-54	61-66	67-72	RECOVERY
OE	9.7 (7.9)	12.2 +2.4	10.7 +2.9	14.9 +5.1	14.4 +4.6	19.7 +5.9	15.6 +3.6	9.9 -
	RAW SCORE	487.8 (479.6)	467.8 -11.2	452.8 -25.2	351.4 -103.6	331.7 -147.3	245.8 -185.0	410.0 -
IR	11.8 (10.2)	15.4 +3.1	15.6 +4.7	20.8 +10.5	17.1 +6.0	21.6 +11.3	12.4 +5.1	8.7 -
	RAW SCORE	1049 (666)	1120 +79	1070 +9	1170 +109	1143 +77	1380 +119	1012 -

In addition to revealing increasing OEs over time, OE raw scores revealed a difference among the four groups of subjects [ $F(3,12) = 11.34, p < .01$ ]: the high Es/low BIS group performed best, as predicted, followed by the high Es/high BIS group, the normal Es/normal BIS group, and the low Es/high BIS group (Table II).

TABLE II: GROUP MEANS FOR PERFORMANCE MEASURES. RAW SCORE MEANS ARE BASED ON ALL PERFORMANCE TRIALS, FROM THE 0-6 HOURS DEPRIVATION TRIAL THROUGH THE RECOVERY TRIAL. DEVIATION SCORE MEANS ARE BASED ON SIX PERFORMANCE TRIALS, FROM THE 13-18 HOURS DEPRIVATION TRIAL THROUGH THE 67-72 HOUR SLEEP DEPRIVATION TRIAL

	MEASURES	GROUP 1: HIGH ES HIGH BIS	GROUP 2: HIGH ES LOW BIS	GROUP 3: LOW ES HIGH BIS	GROUP 4: NORMAL ES NORMAL BIS
OE	RAW SCORE	11.3	10.0	14.8	14.6
	BASELINE	9.0	8.6	10.7	12.1
	DEV. SCORE	+3.1	+1.4	+3.5	+2.3
IR	RAW SCORE	461.9	556.6	334.5	256.6
	BASELINE	538.1	477.3	524.8	353.9
	DEV. SCORE	+76.1	-79.3	+190.3	-97.3
WF	RAW SCORE	15.8	17.8	15.4	12.7
	BASELINE	11.7	12.9	8.6	10.2
	DEV. SCORE	+3.8	+6.5	+6.8	+2.6
ST	RAW SCORE	1073	1095	1162	1137
	BASELINE	1023	1010	1069	1033
	DEV. SCORE	+50	+85	+93	+104

NOTE: ALL MEASURES EXCEPT WORD-FORGETTING (WF) ARE CALCULATED PER 5-MINUTE SEGMENT OF THE VIGILANCE TASK.

Using scores adjusted for baseline differences, the group differences remain [ $F(3,12) = 3.66, p < .05$ ]. With both scores, then, the high Es/low BIS group had significantly fewer errors than either the low Es/high BIS group or the normal Es/normal BIS group, and the high Es/high BIS group fell in between the high Es/low BIS



group and the other two groups. However, the group X trial interaction effect was not significant, failing to support the hypothesis of differing degrees of performance decrement among the groups.

Further analyses for personality effects revealed differences among the subjects with high, normal, and low levels of ego strength [ $F(2, 13) = 14.04, p < .01$ ], and among those subjects with high, normal, and low levels of impulsiveness [ $F(2, 13) = 8.5, p < .01$ ] (Table III).

TABLE III. PERFORMANCE MEASURE MEANS FOR PERSONALITY TRAIT LEVELS. RAW SCORE MEANS ARE BASED ON ALL PERFORMANCE TRIALS, FROM THE 0-6 HOURS DEPRIVATION TRIAL THROUGH THE RECOVERY TRIAL. DEVIATION SCORE MEANS ARE BASED ON SIX PERFORMANCE TRIALS, FROM THE 13-18 HOURS DEPRIVATION TRIAL THROUGH THE 67-72 HOUR SLEEP DEPRIVATION TRIAL. NOTE: ALL MEASURES EXCEPT WORD-FORGETTING (WF) ARE CALCULATED PER 5-MINUTE SEGMENT OF THE VIGILANCE TASK.

MEASURES		EGO STRENGTH		NORMAL ES AND BIS	IMPULSIVENESS	
		HIGH	LOW		HIGH	LOW
OE	RAW SCORE	10.6	14.8	14.6	13.3	9.9
	BAS. SCORE	7.7	10.7	12.1	10.0	6.6
	DEV. SCORE	+3.8	+4.5	+3.3	+4.4	+4.4
IR	RAW SCORE	488.2	336.3	256.6	371.2	507.4
	BAS. SCORE	515.9	524.0	353.9	530.5	499.3
	DEV. SCORE	-37.3	-240.3	-100.5	-139.4	+15.1
WF	RAW SCORE	15.7	15.4	15.9	15.6	7.8
	BAS. SCORE	12.4	5.3	10.2	8.9	12.9
	DEV. SCORE	+6.1	+11.8	+7.6	+9.2	-15.5
RT	RAW SCORE	1006	1162	1138	1124	1095
	BAS. SCORE	1037	1069	1038	1049	1045
	DEV. SCORE	-60	+124	+45	+95	+62

Those subjects with high ego strength performed significantly better than normal Es and low Es subjects, and those subjects with low impulsiveness performed significantly better than normal BIS and high BIS subjects. Again, however, neither the Es or BIS groups X trials interaction terms was significant.

Omission errors were significantly different during the two levels of task complexity ( $t = 7.58, df = 15, p < .001$ ). The mean number of omission errors was greater (13.93 OEs) during visual and auditory monitoring than during visual monitoring alone (11.82 OEs).

**Interrogation Rate:** Across the sleep deprivation trials, interrogation rate scores showed significant decrements [ $F(7, 45) = 10.03, p < .01$ ]. The same results for trials were obtained using deviation scores [ $F(5, 60) = 5.89, p < .01$ ]. Interrogation rates declined 50 % from baseline scores to the end of the 72-hour sleep deprivation period.

The four groups of subjects differed in raw score interrogation rate [ $F(3, 12) = 4.98, p < .05$ ]. The group which had the highest mean interrogation rate was the high Es/low BIS group. The next best performance was by the high Es/high BIS group, followed by the low Es/high BIS group and the normal Es/normal BIS group. However, using baseline adjusted scores the groups do not differ [ $F(3, 12) = 1.57, p > .10$ ].

Further analysis of personality effects showed no differences related to Es but the subjects with high, normal, and low levels of impulsiveness differed on interrogation rate [ $F(2, 13) = 5.85, p < .05$ ]; the low BIS subjects had significantly faster interrogation rates than did the high BIS subjects, and the normal BIS subjects fell between the high and low groups. Again, the groups X trial interactions were not significant.

Interrogation rates differed during the two levels of task difficulty ( $t = 3.20, df = 15, p < .01$ ). There was a higher interrogation rate (397.4 meters examined per 5 minutes) during visual and auditory monitoring than during visual monitoring alone (371.6 meters examined per 5 minutes).

**Word Forgetting:** Across the sleep deprivation trials, word forgetting scores showed significant increases [ $F(7, 84) = 19.16, p < .01$ ]. Using deviation scores, word forgetting across sleep deprivation trials was also significant [ $F(5, 60) = 7.61, p < .01$ ]. The number of words forgotten increased 88 % from baseline scores to the end of the 72-hour sleep deprivation period.

Analyses of the word-forgetting scores showed no differences among the four groups of subjects using raw scores or using baseline scores. There were also no differences in raw scores among the levels of the two personality variables considered alone. However, an analysis of the deviation scores of the high, normal and low ego strength subjects showed a significant difference [ $F(2, 13) = 4.21, p < .05$ ]. The low Es subjects performed worst, followed by the normal Es subjects, and the high Es subjects. Once again the groups X trials interactions were not significant.

#### Reaction Time:

Reaction Time raw scores also showed significant increments across the sleep deprivation trials [ $F(7, 84) = 11.07, p < .01$ ] as did deviation scores [ $F(5, 60) = 5.76, p < .01$ ]. The mean increase in reaction time from baseline scores to the end of the 72-hour sleep deprivation period was 10 %.

Further analyses of the reaction time raw scores and deviation scores showed no differences among the four groups of subjects, nor among the three levels of the

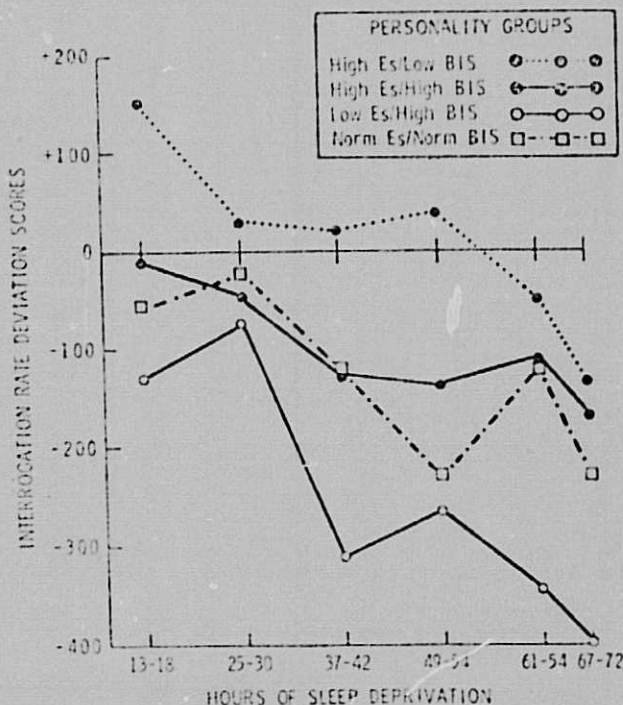


Figure 1: Interrogation rates of personality groups throughout the period of sleep deprivation.

two personality traits, ego strength and impulsiveness. There was also no difference ( $t = 1.87$ ,  $df = 15$ ,  $p > .10$ ) between the reaction times during the two levels of task complexity.

In summary, all four performance measures revealed sleep deprivation effects for all subjects. In addition, OE and IR were related to task complexity but RT was not. Omission errors and interrogation rate differed among the four personality groups. The differences between groups on the interrogation rate parameter are shown in Figure 1. Both of these measures also differed for groups constituted on the basis of Es scores alone and BIS scores alone. In addition, word forgetting deviation scores also showed differences related to Es. The reaction time measure showed no differences related to personality. While the high Es/low BIS group performed best on three of the four measures, there were no significant group X trial interactions, failing to support the hypothesis of differential rates of performance decrement.

### Discussion

These results support those reported previously on the effects of sleep deprivation on vigilance performance (Williams, et al., 1970; Wilkinson, 1965). As in those studies, omission errors, word forgetting, and reaction time in this experiment were sensitive to sleep loss. As in these previous studies also, greater task complexity (word forgetting with visual vigilance) is associated with poorer performance. In addition, interrogation rate, a variable not quantified in earlier experiments, also showed progressive deterioration.

These results also generally support the results obtained in earlier studies on the relationship between ego strength and impulsiveness to vigilance performance (Barratt, 1967; Barratt and White, 1969; Strausbaugh and Roessler, 1970); high ego strength and low impulsiveness were related to better vigilance task performance. In addition, the combination of high ego strength with low impulsiveness in this experiment is associated with better performance. This relationship has not previously been demonstrated.

However, the hypothesis that ego strength and impulsiveness and combinations of the two would be differentially related to performance decrement was not supported. For example, low ego strength subjects did not deteriorate more rapidly in their performance than other subjects. Thus, these data do not support those reported by Strausbaugh and Roessler for 24 hours of sleep deprivation. Since the duration of sleep deprivation was longer in this experiment and the vigilance task more difficult, it seems probable that the results of this experiment are the more valid.

Nevertheless, these results also indicate that personality variables are predictive of vigilance performance over time, in that given information on the ego strength and impulsiveness scores, it is possible to predict those subjects who will perform best, not only early in sleep deprivation but later as well. While it is possible that an

ally bring all subjects to an asymptotic and equally low level of performance, it appears that, up to 72 hours at least, subjects maintain their ranks in level of performance and these ranks are related to the personality variables of ego strength and impulsiveness.

Some variables of possible relevance to predicting differential rates of performance decrement were not quantified in this experiment. Taub and Berger (1973) have shown that state measures of anger-hostility, deactivation-sleep, and inertia-fatigue (as opposed to the personality trait measures with which we were concerned) are predictive of the degree of deterioration under stress. It is also possible that other performances would deteriorate differentially in relation to personality. For example, tasks with a greater cognitive component, such as reading comprehension, might be more sensitive in this respect. Future experiments should include quantification of such variables.

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**Personality, Physiology, Performance, and Sleep Deprivation**

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Some individual variability which has characterized studies on the effects of sleep deprivation upon human performance is related to personality. In an attempt to clarify the sources of this variability, subjects were selected on the basis of personality variables. Two major orthogonal dimensions account for most of the variance as reported by most factor-analytic studies of self-report personality measures. These dimensions are extroversion-introversion and neuroticism-ego strength. The Barratt Impulsiveness Scale (BIS) and the Barron Ego Strength Scale (Es) were used respectively to tap these personality dimensions. The BIS and Es have been associated with performance measures and broad coping ability and should therefore be well suited for prediction of performance on a sustained vigilance task under stress.

Since a high Es score is associated with superior performance and a high BIS score is associated with inferior performance, the performance of persons scoring high on both scales was predicted to be similar to that of subjects scoring near the mean on both measures. Similarly, those persons with low Es/low BIS scores were predicted to perform at the level of subjects with Es and BIS scores near the mean. In addition, superior performance from high Es/low BIS subjects, and inferior performance from low Es/high BIS subjects was predicted.

Sixteen male subjects (mean age 24.6 years) were selected based on their Es and BIS scores falling  $\pm 0.75$  S.D. from the mean. Since no low Es/low BIS group could be formed the four groups were: high Es/high BIS (N = 3); high Es/low BIS (N = 4); low Es/high BIS (N = 4); and normal Es/normal BIS (N = 5). After one practice session, the subjects returned to the laboratory in the evening for the 3-night sleep deprivation study. They were tested for a total of 12, 6-hr sessions, for a total of 72 hr of wakefulness. They were then allowed to sleep overnight and upon waking were given another 6-hr test session, the recovery session. The data reported here are derived from a complex vigilance performance task (for details see Strausbaugh and Roessler, Perceptual and Motor Skills, 31:671-677 (1970)).

Each vigilance session began with a 5 min rest period followed by a 10 min period during which S was required to monitor the 3 m visual display. Then during the next 20 min S was presented a list of 25 words through earphones while monitoring the visual display. Different word lists equated for difficulty were used in each testing occurring once every 6 hr throughout the deprivation period. Another 10 min of visual monitoring followed, after which S was asked to recall and write down as many of the 25 words as he could remember, regardless of order of presentation. Order of the visual monitoring only and visual monitoring - word memory conditions was thus counter-balanced within subjects. S was given 10¢ for every word correctly recalled. Only the data from trials 1, 3, 5, 7, 9, 11, 12, and 13 (the rebound session) were used for analysis in order to reduce data volume.

Physiological measures monitored during these sessions included heart rate, skin conductance, and respiration.

Results: Analyses of variance for repeated measures were performed on the three physiological measures and on the four performance measures available from the vigilance task: (a) number of signals undetected, i.e., omission errors (OE), (b) number of meters examined in a 5-min interval, i.e., interrogation rate (IR), (c) number of words forgotten of the 25 words presented, i.e., word-forgetting scores (WF), and (d) average reaction times (RT) for those meter deflections to which S attempted to respond. All of these measures were subjected to analyses comparing: (a) sleep deprivation trials (6 hr test sessions), (b) the four groups of subjects selected, (c) the three levels of each personality dimension, and (d) the two levels of vigilance task complexity (visual monitoring only or visual plus auditory monitoring).

In summary, heart rate and all four performance measures revealed sleep deprivation effects for all subjects (see Table 1). In addition, OE, IR, and WF were related to task complexity but RT was not. Omission errors and interrogation rate differed among the four personality groups (see Table 2). The differences between groups on the interrogation rate parameter are shown in the displayed figure. Both of these measures (OE and IR) also differed for groups constituted on the basis of Es scores alone and BIS scores alone (see Table 3). In addition, word forgetting deviation scores also showed differences related to Es. The reaction time measure showed no differences related to personality. While the high Es/low BIS group performed best on three of the four measures, there were no significant group X trial interactions.

Heart rate covaried significantly with the performance measures, omission errors and interrogation rate, especially for the low Es/high BIS group. Those subjects with high ego strength were found to have lower skin conductance over the sleep deprivation period. Respiration did not show consistent variation either with personality or sleep deprivation.



TABLE 1

PERFORMANCE MEASURE MEANS ACROSS SLEEP-DEPRIVATION TRIALS

		Hours of Sleep Deprivation						<u>Recovery</u>
		<u>0-6</u>	<u>13-18</u>	<u>25-30</u>	<u>37-42</u>	<u>49-54</u>	<u>61-66</u>	<u>67-72</u>
OE	Raw Score	9.7	12.2	10.7	14.9	14.4	15.7	15.6
	Dev. Score	(9.8) <sup>a/</sup>	+ 2.4	+ 0.9	+ 5.1	+ 4.6	+ 5.9	+ 5.8
IR	Raw Score	548.0	467.8	452.8	354.4	331.7	324.0	246.8
	Dev. Score	(479.0) <sup>a/</sup>	- 11.2	- 26.2	- 133.6	- 147.3	- 155.0	- 232.2
RT (in msec)	Raw Score	1040	1100	1070	1170	1140	1180	1170
	Dev. Score	(1061) <sup>a/</sup>	+ 39	+ 9	+ 109	+ 79	+ 119	+ 109
WF	Raw Score	11.8	15.4	15.0	20.8	17.1	21.6	19.4
	Dev. Score	(10.3) <sup>a/</sup>	+ 5.1	+ 4.7	+ 10.5	+ 6.8	+ 11.3	+ 9.1
								8.7
								-

<sup>a/</sup> Score in parentheses is baseline score, i.e., mean of first and rebound session.

Note: All measure except word-forgetting (WF) are calculated per 5-min segment of the vigilance task.



TABLE 2

GROUP MEANS FOR PERFORMANCE MEASURES

		Group 1: High Es <u>High BIS</u>	Group 2: High Es <u>Low BIS</u>	Group 3: Low Es <u>High BIS</u>	Group 4: Norm. Es <u>Norm. BIS</u>
OE	Raw Score <sup>a/</sup>	11.3	10.0	14.8	14.6
	Baseline	9.0	6.6	10.7	12.1
	Dev. Score <sup>b/</sup>	+ 3.1	+ 4.4	+ 5.5	+ 3.3
IR	Raw Score	453.9	506.6	336.5	256.6
	Baseline	538.1	499.3	524.8	353.9
	Dev. Score	- 93.1	+ 15.1	- 245.8	- 130.4
RT (in msec)	Raw Score	1073	1095	1162	1138
	Baseline	1023	1048	1069	1088
	Dev. Score	+ 58	+ 62	+ 122	+ 65
WF	Raw Score	15.8	17.8	15.4	15.9
	Baseline	11.7	12.9	6.8	10.2
	Dev. Score	+ 5.6	+ 6.5	+ 11.8	+ 7.6

a/ Raw score means are based on all performance trials, from the 0 to 6 hr deprivation trial through the rebound trial.

b/ Deviation score means are based on six performance trials, from 13 to 18 hr deprivation trial through the 67 to 72 hr sleep deprivation trial.

NOTE: All measures except word-forgetting (WF) are calculated per 5-min segment of the vigilance task.

TABLE 3

PERFORMANCE MEASURE MEANS FOR PERSONALITY TRAIT LEVELS

		<u>Ego Strength</u>		<u>Normal Es/ Normal BIS</u>	<u>Impulsiveness</u>	
		<u>High</u>	<u>Low</u>		<u>High</u>	<u>Low</u>
OE	Raw Score <sup>a/</sup>	10.6	14.8	14.6	13.3	9.9
	Baseline	7.7	10.7	12.1	10.0	6.6
	Dev. Score <sup>b/</sup>	+ 3.8	+ 5.5	+ 3.3	+ 4.4	+ 4.4
IR	Raw Score	488.2	336.5	256.6	391.2	507.4
	Baseline	515.9	524.8	353.9	530.5	499.3
	Dev. Score	- 30.3	- 245.8	- 130.5	- 180.4	+ 15.1
RT (in msec)	Raw Score	1086	1162	1138	1124	1095
	Baseline	1037	1069	1088	1049	1048
	Dev. Score	+ 60	+ 122	+ 65	+ 95	+ 62
WF	Raw Score	16.9	15.4	15.9	15.6	17.8
	Baseline	12.4	6.8	10.2	8.9	12.9
	Dev. Score	+ 6.1	+ 11.8	+ 7.6	+ 9.2	6.5

<sup>a/</sup> Raw score means are based on all performance trials, from the 0 to 6 hr deprivation trial through the rebound trial.

<sup>b/</sup> Deviation score means are based on six performance trials, from the 13 to 18 hr deprivation trial through the 67-72 hr sleep deprivation trial.

NOTE: All measures except word-forgetting (WF) are calculated per 5-min segment of the vigilance task.